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BACK INJURY PREVENTION

An Ergonomic Approach

Alberta
LABOUR
Occupational Health and Safety Division

BACK INJURY PREVENTION
An Ergonomic Approach

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Note: The illustrations used in this publication were provided through the courtesy of the Workers' Health Centre.

INTRODUCTION

Back Injuries - What Are They?

The back is a very complex part of the body. It consists of bones, discs, ligaments, muscles and nerves. Problems can occur in any one or a combination of these parts. Many back problems occur in the lower back. Back problems can range from discomfort, through more severe pain that causes some impairment, to very severe pain that causes disability. The amount of back pain tolerated by a working person depends on the nature of their work. For example, back pain that is uncomfortable for an office worker could be disabling for a labourer.

It has been estimated that 80% of the population suffers some back pain during their lifetime; even four-legged animals suffer back pain. Disabling back pain has serious implications for a worker's quality of life. It results in personal suffering, disrupts family and social life, and affects the worker's employability. It is unlikely that we will ever be able to eliminate the problem of **back pain**. However, we *can* do a lot to reduce the incidence of what has been called **back pain disability** -- that is, the consequences of back pain in terms of how a person functions.

Purpose of This Booklet

Back injury prevention approaches, such as worker training and selection, have not on their own proved to be effective in reducing the numbers of back injuries or their costs. The intent of this booklet is to encourage a broader approach to reducing the occurrence and severity of occupational back injuries.

Much has already been published on worker education, back schools, exercise programs and worker selection. This information is readily available. There is, however, a need for more information on how to reduce the risk of back injury through physical and organizational design changes. This booklet discusses how a job can be designed to reduce the likelihood of a back injury. It is aimed at those who can best effect these changes: managers, supervisors, purchasers and engineers.

The main focus will be on altering the risks associated with manual handling tasks since many of today's workplace injuries are related to these tasks. This booklet looks mainly at back injury risk factors, design changes in the workplace and organizational factors.

Occupational Back Injuries - Past and Present

3,500 years ago, the ancient Egyptians knew about low back pain. Three-hundred years ago we see the first references to occupational low back injuries. Today, the problem is still with us.

In Alberta, back injury claims account for about 30% of all WCB claims, with 18% of all claims being for sprains or strains to the back. This problem is not unique to Alberta. In Britain about 15% of all occupational injuries are strains and sprains to the back. In the United States, estimates of between 19-26% have been made for low back compensation claims as a percentage of total claims. Even without the statistics everyone just *knows* that back injuries occur in every industry and in almost all occupations.

Prevention Strategies

Considerable time, effort and money has been spent this century trying to bring the back injury problem under control. A variety of methods have been used although usually in isolation and with varying degrees of success. Common approaches include:

Worker Education

Worker education in "proper" lifting techniques, strength and fitness, has long been the main way employers and health and safety professionals tried to reduce the incidence of back injury. When worker education is included as **one component** of a back injury prevention program, rather than as the only component, it is certainly useful. This is especially true when education is provided to workers who have previously suffered back pain or disability. There are reasons why the use of worker education has not been highly-effective on its own as a back injury prevention strategy:

- in many cases the design of the job, work tasks, equipment or environment is responsible for the back injury risk factors that exist. In addition, workers seldom lift for an entire shift and other activities such as pushing, pulling, carrying, twisting, prolonged sitting or standing, etc., may contribute to the stresses;
- inconsistencies among various "safe lifting" programs. The key factors upon which people do seem to agree, are to keep a good foot base, keep the object close to the body, keep the shoulders over the hips and lift in a smooth, controlled manner;
- "safe lifting" requires much more energy (because body weight is lifted with the load), is sometimes harder to perform (e.g., for people with bad knees), and may take longer to do. These may be some reasons for poor compliance.
- in some lifting tasks (e.g., where a load is too wide to fit between the knees) "safe lifting" may be riskier than lifting with straight knees, a bent back and the load closer to the body.

Overall, there is a lack of controlled studies showing that worker instruction in safe lifting is effective. Also, there is conflicting evidence on the benefits of strength and fitness programs. An important and often overlooked audience for education is those who make decisions about the design of jobs and work environments (e.g., managers, supervisors, purchasers, etc.).

Worker Selection

Worker selection has also been used, especially for jobs where it is difficult or impossible to design out back injury risk factors (e.g., uncontrollable firefighting hazards). Here, employers try to choose the "best" workers for physically demanding jobs by administering fitness and strength tests, and by having workers undergo comprehensive medical exams. A previous back injury can increase the likelihood of future back problems, so the medical history is perhaps the most useful tool here. Certain fitness and strength tests may have value if the tests are highly specific to the job requirements. Care must be taken to ensure that specificity is high, the tests are valid (i.e., they measure what is meant to be measured), and that the tests do not violate human rights legislation. Studies in this area show:

- that even with a thorough medical examination, there is still a poor rate of being able to identify individuals at risk;

- poor correlations between x-rays and back injury incidence. It is therefore difficult to justify the increased radiation exposure and increased cost of routine lower back x-rays as part of a pre-placement medical. (Note: This method is not commonly used in Canada.);

- that most fitness and strength tests, especially isometric tests, show a poor relationship to the incidence or severity of back injuries that can happen. In fact, one major recent study found that stronger workers actually had more claims;

- that some strength tests have *caused* back injuries. This brings in both ethical and legal problems for companies administering these tests, especially if people are being tested before being hired; and

- that fitness levels rarely remain constant after a person is hired.

Back Schools

Back schools are a form of worker education that attempt to educate the worker in all aspects of back care. They may include some or all of the following topics: anatomy and physiology, posture, fitness, body mechanics, nutrition, stress management and relaxation, pain control, job simulation, etc. There seems to be evidence that workers who have already had back injuries may be helped by this approach, but that as a preventive technique, it may be less successful.

Medical Management

A medical management approach to reports of back pain or injury seeks to prevent them from becoming back disability cases. With this method, supervisors and managers are trained to show concern for worker needs, to avoid making judgements and to encourage the worker to seek immediate treatment. Early conservative treatment is part of this approach, as are follow-up and communication, early return to work, and light duty or modified work. The majority of back injuries that do occur can be resolved quickly with appropriate treatment. Much success in reducing lost-time and costs has been achieved through this approach alone.

Work Hardening

Work-hardening involves gradually introducing a worker to his/her duties over a 2 to 4 week period. It is, in effect, a physical training program designed for a specific job. Manual workers, especially, are basically industrial athletes. The more strenuous their jobs are, the more important the work hardening. Work hardening can be usefully applied to new workers who will be required to perform physically demanding jobs, and to those workers who are returning to work from a vacation or following an injury.

Occupational Ergonomics

Ergonomics is both a science and a technology. It studies human limitations and capabilities, and systematically applies this knowledge to the design of workplaces. The goal is to match workers (limitations and capabilities) to their jobs, to increase both their well-being and performance at work.

Information is available that shows a relationship between certain job activities and the incidence of compensable back pain. The ergonomic approach aims to reduce workplace risk factors through good job design. By reducing worker exposure to risk factors, the chance of an initial or recurring episode of a back injury is also reduced.

What Method to Use?

Back injuries are complex, requiring a broad approach to effectively prevent them. There is no simple solution to this complex problem. Yet, of the approaches discussed, job design is considered to be one of the most effective strategies that can be used to prevent back disabilities. Therefore, this booklet will focus on where, and how, ergonomic principles can be applied at the workplace to prevent back disabilities. For more detailed information about the effectiveness of other strategies discussed, refer to the Alberta Labour publication, "Approaches to the Control of Back Pain in Industry" (TSB-105).

THE ERGONOMIC APPROACH

Risk Factors

Both personal and workplace risk factors (Table 1) have been looked at to determine what can trigger back pain in the workplace. Personal factors can be grouped according to those concerned with lifestyle and those belonging to a person's unique make-up (i.e., what we do vs what we are). Many activities in a person's life have the potential to lead to back injury: a person's job, shovelling the walk, lifting the children. The patterns of work activity have been shown to be more significant than personal characteristics when it comes to reducing a worker's chance of suffering from a back problem. There is plenty of information which shows evidence of certain work patterns (e.g., heavy work, frequent lifting and bending, static work postures, etc.) that increase the load on the back. When dealing with back injury prevention at work, it is important to consider all of the risk factors since, at times, these factors act alone, and at other times, they act in an additive fashion.

Personal

Most of the factors that are listed in Table 1 are determined by the way the job and work environment are set up. The worker may have input into some of these factors (e.g., skills, overtime, work methods), but to a large extent these are out of his/her control.

Of the personal risk factors that are listed, only the last two, fitness and lifestyle, are ones that are usually within the individual worker's control. Fitness and lifestyle should be encouraged, however, it is important to recognise the limits of these approaches (i.e., they are controllable only within the limits of genetics, gender, motivation and opportunity). Employers that encourage worker fitness can help by providing on-site exercise facilities, by providing incentives (e.g., subsidize memberships in fitness clubs), or can actively promote fit, active, healthy lifestyles.

Fitness and lifestyle strategies should also include training in both task skills and back health and safety. Training that is provided to workers should be ongoing (e.g., offer refresher courses), and the training of supervisors and managers should not be neglected. This will help them to make better decisions concerning personal and workplace factors.

It makes sense that if a company truly wants to make significant reductions in back injury incidence and severity rates, efforts should be focused on areas that are more controllable. These are, the:

- object,
- task,
- organisation, and
- environment.

TABLE I

SOME BACK INJURY RISK FACTORS ASSOCIATED WITH MANUAL HANDLING OF LOADS

OBJECT	
WEIGHT	(too heavy)
DEPTH	(too deep)
CENTRE OF MASS	(unbalanced)
WIDTH	(too wide)
HEIGHT	(too tall)
HANDLES	(no handles, handles hurt the hand or are awkward to use)
TASK	
FREQUENCY	(too often)
REACH	(too far)
HEIGHT	(too low, high)
DURATION	(too long)
TWISTING	(any)
DISTANCE CARRIED	(too far)
ENVIRONMENT	
SPACE	(crowded)
OBSTACLES	(reaching over and around)
FOOTING	(slippery)
ORGANIZATION	
MANAGEMENT COMMITMENT	(does it exist? written policy?)
EDUCATION/TRAINING	(quality, quantity; given to managers, workers, professionals)
MANAGEMENT STYLE	(authoritarian vs participative)
PERSONAL	
AGE	(changes in body - strength, recuperative abilities)
SIZE	(people range in body heights and limb proportions)
GENDER	(differences in strength, size)
PREVIOUS BACK INJURY	(out of workers' control)
STRENGTH	(changes with age, health status; genetically limited)

FITNESS	(are they too tired after work? do they have time? do they see the need? are they interested in what's available? is it available to them?)
LIFESTYLE	(smoking, weight control)

Adapted From: Stubbs, D. (1991). Ergonomics and back pain. Occupational Health, March, 1991, pp. 82-85. (Table 1, p.82)

Workplace

A significant part of a person's day is spent at work, so a person's job can have a large potential impact on the likelihood of back injury. Sometimes, a light task or simple movement may cause pain. In other cases, there is a gradual onset of pain or disability with no obvious single cause. It is important to remember that backs, like other parts of the body, may be injured due to a single traumatic event, or through repeated wear and tear that can add up to more serious damage.

What are some of the risk factors for back injury in the workplace? The first one most people think of is heavy weights. Lifting heavy loads is often a significant factor but if you look at Table 1, you will see that there are several other factors that can interact to increase the risk of an occupational back injury.

The workplace and personal risk factors above the line in Table 1 are, to a large extent, outside of the worker's control. In a lot of work situations, the parameters within which the worker must work are usually determined by decisions made by the employer, engineer/designer, purchaser, supervisor, facility architect/manager, etc. These people have the greatest influence over the design of the workplace and, therefore, need to be aware of how their decisions can affect the introduction or removal of these back injury risk factors.

Assessing, Evaluating and Monitoring the Work Site for Risk Factors

Before action can be taken to reduce the back injury risk factors, you need to know what and where the specific types of risks are at your worksite. There are many assessment and analysis methods that can be used to determine these risk factors. The assessment that is carried out will depend on the type of the problem (e.g., lifting vs pushing task) and the stage you are at in determining the problem (e.g., targeting an area for change vs in-depth analysis of a specific problem).

Record keeping

Record keeping offers a very good method for tracking where and how injuries occur in an organisation. Many companies do not analyse information they collect, and so do not take full advantage of the records they already have. Often, in large companies, separate records are kept by separate departments (e.g., health and safety, medical, personnel, production) with little or no coordination or collaboration among them. Other companies, simply do not collect or keep good records at all.

What records should be kept and what indicators should you be looking for? In addition to the normal personnel, medical and other records kept by a business, following are some records or calculations that can be useful in determining risks and problems areas within your company.

Personnel:
- jobs and task descriptions
- shift records (length of, rotation periods...)
- length of time employed
- length of time off during a vacation or injury
- absenteeism rate for departments/jobs/tasks
- turnover rate for departments/jobs/tasks
- training records (type, how often ...)

First Aid/Medical/Health and Safety:
- specific part of body injured
- diagnosis of injury
- severity of injury (e.g., extent of disability)
- detailed mechanism of injury (e.g., work activities/motions involved)
- detailed treatment
- time lost
- previous injuries

Production:
- targets (e.g., units produced or moved per day)
- increases or decreases in productivity
- process, tools or equipment changes
- handling equipment used
- maintenance records
- quality control records

Accounting:
- personnel costs (absenteeism, turnover, etc.)
- incident costs (including overtime, replacing/retraining workers, damaged equipment/products, etc.)
- WCB assessments
- in-house medical costs
- production costs (costs per unit produced, etc.)

These records should be reviewed and analysed periodically to determine high-risk situations. The information can be used to: compare tasks and work areas that are experiencing problems to help set priorities for ergonomic change; predict tasks and work areas that may be vulnerable to future injuries; and, to measure the results of change. Cost data and the benefits that are expected with change (cost/benefit analysis) will be important to help develop a case for change.

Worker Input

Workers know their own jobs best and will know what activities are hard on their backs. To gather their input, a formal method usually works better than a "suggestion box." Well-designed questionnaires or interviews are a couple of ways in which worker input can be gained. Another way is to have worker representation on any committee that looks at worksite, task, process or other changes. It is important that workers see their suggestions are acted upon.

Task and Work-Area Analysis

A job can be described according to the tasks that are performed (e.g., loading boxes onto pallets). These tasks can then be analysed according to their demands on workers (e.g., loads on the spine). This helps to target where interventions might be needed to reduce back injury risks.

A checklist offers a quick way to determine the general presence of back injury risk factors in your workplace. General and specialised check-lists are available (see Appendix). You should even be able to design your own checklist to address needs that are specific to your own company. Table 1 can be used to help guide you. Time and patience will be necessary, since it is not always easy to recall and break down a job into its components. Use a separate sheet for each task and then look for work areas where the presence and extent of risk factors (e.g., reaches, heavy weights, high repetition, twisting, etc.) are high. Work area dimensions, work layout, work flow and patterns, and environmental factors are important workplace elements to describe and measure, as well.

In-depth analysis of a task (e.g., lifting) will be required to determine the level of risk (e.g., exceeds the MPL -- refer to NIOSH below). Detailed analysis techniques (e.g., biomechanical, physiological) are available and will be needed to accurately measure the risk(s) and to evaluate the effectiveness of any changes that are made. Ergonomics professionals, who are trained to carry out such analyses, can be consulted for information and assistance.

NIOSH Lifting Guide

The U.S. National Institute of Occupational Safety and Health (NIOSH) (see Appendix) published a formula in 1981 to help assess lifting tasks for back injury risks. The formula in *The Work Practices Guide for Manual Lifting* is based on a number of assumptions (i.e., the task involves: no twisting, two-handed lifts, good hand-holds, balanced load, unrestricted posture, one lift every five minutes, good footing, good environment). In practical terms, manual handling tasks often involve more than just lifting and lowering. This calculation does not take into account the effects from vibration, sudden movements, carrying, or pushing and pulling loads. In other words, it can be usefully applied to some, but not all, situations. It does, though, provide a useful general guide to determine safe lifting ranges. If you use the guide to assess a lifting task that meets some but not all of the guide's assumptions, then you can assume that you must give a greater safety margin than the result suggested by the formula.

The formula in the 1981 guide gives two results:
1. an Action Limit (AL), and a
2. Maximum Permissible Limit (MPL).

If a lift is analysed and falls below the AL, the lift is considered acceptable for about 99% of men and 75% of women. The MPL is a calculated by multiplying the AL three times. Tasks above the AL but below the MPL are considered to pose a moderate level of risk. These tasks should be redesigned or changed through administrative controls, such as worker training or selection. A lift above the MPL indicates a level that would be a serious risk for nearly all workers. Tasks above the MPL need to be redesigned.

NIOSH is presently modifying its lifting guide, taking into account the latest research and a more modern philosophy. Changes include:

- the incorporation of a "coupling" factor, since in most industrial lifting situations there are no handles;
- a factor to account for "asymmetrical" lifts (i.e., lifts involving twisting);
- a more realistic "lifting frequency" component;
- a changed emphasis among the various components of the formula, especially reducing the "load constant" factor and increasing the importance of the "horizontal distance" factor; and
- the elimination of the MPL. Tasks exceeding the MPL are often perceived as obviously hazardous and are not usually carried out by workers without some mechanical assistance. More commonly carried out by workers are those tasks that fall between the AL and MPL. These tasks are often perceived (mistakenly) as being safe. So when changes are needed training is often seen as an acceptable alternative to changes to the work system itself (i.e., reinforcing the status-quo approach). NIOSH will be taking a more "public health" approach with re-design being emphasized as the primary corrective action for any weight above the AL.

Snook's Approach

In many manual materials handling jobs, lifting and lowering make up only a part of back injury risk situations. Pushing, pulling and carrying are some other movements that must be considered as well. Assessment of the risks in these activities is often done using tables devised by Dr. S. Snook (see Appendix). These tables are based on psychophysical tests. Psychophysical tests combine the physical effects of tasks with workers' perceptions of the demands of those tasks to determine an "acceptable weight of a lift, or force of a push or pull." The tables are quite extensive and the reader should refer to the reference given in the appendix.

Ergonomics Expertise
Professional ergonomists are trained to help identify and solve workplace problems that affect workers (e.g., back injuries). Generally, the ergonomist's expertise includes knowledge about human limitations and abilities, and about methods to assess and improve workplace designs. They rely on a variety of assessment, solution and evaluation techniques to do this. Their expertise can be specialised or general in how they approach ergonomic problems and their areas of application may vary. The Human Factors Association of Canada (see Appendix) is the professional body for ergonomists in Canada.

(Re-)Design of High-Risk Tasks

General
Ergonomics aims to fit the demands of work tasks to the capabilities of workers (i.e., fit the job to the person). Just as every machine has things it can do and things it cannot do, so it is with workers. Some form of design solution can be applied (to equipment or tools used, to work areas, and to task(s) performed) to control most of the risk factors listed in Table 1. This booklet will go through some of these risk factors, one-by-one, and will look at possible options to improve the situation.

As mentioned earlier, one should always be aware that workplace back injury problems can be complex. Implementing a single change may eliminate a specific concern, but it may not solve the entire problem. One must keep in mind the range of risk factors that exist since and how they may be contributing to another or larger problem.

Applying the ergonomics approach is an on-going process. Every change that is introduced to a job or work area has the potential to introduce new problems. Changes should be carefully evaluated and monitored to prevent such problems.

Solutions need not be expensive; some obviously will be. Other solutions will cost nothing or very little. For example, the organisation can change how it approaches back pain complaints, can use extra pallets or reposition work/storage heights/reaches, or can use its in-house expertise to generate solution ideas and to make simple changes to equipment or tools, all for little or no cost.

Retrofitting an existing facility is usually more expensive than if it were carefully designed from the start. Against the costs to change, though, must be weighed the cost of even a single serious back injury. Some of these costs can include: medical expenses, WCB assessments, equipment or product damage, overtime, training of replacement workers, retraining of injured workers, supervisor's time and, of course, the pain and suffering caused to a good worker. Carefully analyse your records to keep track of these costs, especially the not-so-obvious ones, and weigh them against the benefits of making changes.

During all points of the process, it is especially valuable to consult your workers for their input. Their responses should be seriously considered since, not only do they know their jobs better than anyone else, they are also the ones who will have to accept and live with the changes.

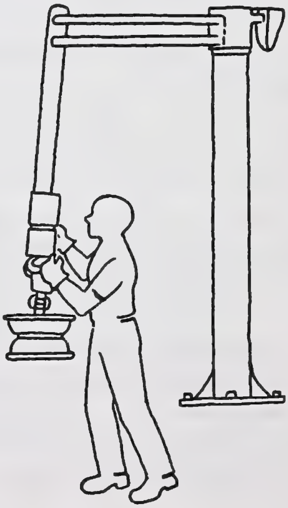
Object Factors

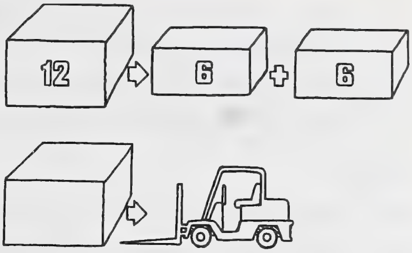
· *Weight and Force*

The weight of a load is the factor that most people think of when considering the causes of their back injuries. It is an important factor: the greater the weight a worker handles, the greater will be their risk of a back injury. Weight, however, is not the only factor that is important. Depending on the task, other factors (e.g., the horizontal distance of the load) can be equally, if not more important. One point to keep in mind is that the upper body itself has considerable weight. When a worker is required to lean forward or sideways while lifting, the weight of the upper body will be added to the weight of the object. In many cases, the upper body weight is greater than the object itself.

Possible Solutions:

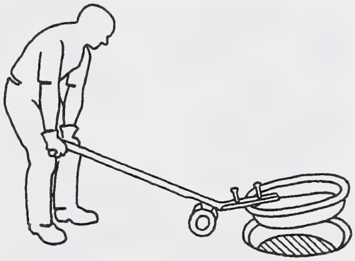
- The basic principle here is to remove or reduce the need to handle stressful loads. Automation can change a worker's job from "handling" a load to "controlling" a machine that handles the load.
- Instead of having workers carry stressful loads, provide roller or powered conveyor systems.
- To reduce the stress of lifting, provide mechanical lifting assists such as industrial manipulators or patient hoists. Be sure that the equipment is maintained, usable in work areas, and that the design is suitable to allow the worker to get the job done.
- To support the weight of heavy tools they can be suspended from balancers.
- Decrease the weight where possible (e.g., put items in smaller boxes or bags).
- Increase the weight to eliminate manual handling altogether. In this case, the object is made so heavy that is can only be handled by cranes, forklifts, etc.
- Mark the weight on the object being lifted so workers are able to decide the best way to move the object.





- Two-person lifts can sometimes be used. The drawbacks with this are that coordination problems can happen. In addition, two people cannot lift twice the weight that one person can (as is commonly thought). In fact, a two-person team can lift about two-thirds the sum of what each individual can lift (Health and Safety Commission, 1991 -- see Appendix).

- Reduce the pushing and pulling forces on carts, stretchers, and other equipment used by workers. Forces can be reduced by ensuring correct wheel size, proper castors, good flooring, handles and regular equipment maintenance.



- To eliminate the need to manually lift or empty a container, provide a tilt mechanism or a lifting cart for barrels, tureens, etc.
- Avoid manual handling while seated. This is because workers can exert less strength and the lift is usually farther away from the body in a sitting position.
- Provide levers to assist workers that are turning or lifting heavy, awkward loads such as a manhole cover.

Purchase Order

Maximum Load

Kilograms

- For moving partially-abled patients, turntables can be useful in that they allow the patient to take some of their own weight during some moves.
- Order products that are packaged in lighter amounts from your supplier(s).

· *Depth*

Depth refers to the distance that a worker must reach in order to grasp the "balance point" of an object. For instance, a long, rectangular box can be grasped closer to the body if it is oriented cross-wise rather than length-wise. The greater the depth of an object, the greater the risk of a back injury.

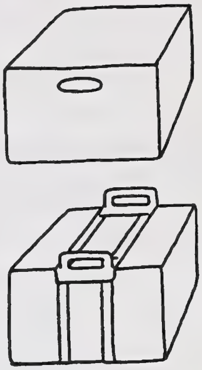
Possible Solutions:

- Change the shape or orientation of a load so it can be grasped closer to the body.

- Use mechanical aids to lift objects that involve reaching.
- A 30cm distance (from the edge of the object to the hand-hold) has been suggested as a maximum distance (National Occupational Health and Safety Commission--see Appendix).

· *Handles*

Lack of properly designed handles on objects can contribute to an increased risk of back injury. For example, a box that is designed without handles requires a worker to begin a lift that is positioned at too low of a level (e.g., at floor level instead of 20 or 30 cm higher). Grasping without handles can also increase the risk of the load slipping.



Possible Solutions:

- To enable the hands to grasp the load better, try cutting comfortable finger slots in boxes, attaching clamp-on handles to boxes or bags, or try providing handles on stretchers/gurneys.
- Patient trnasfer belts can often be used when moving patients.

· *Centre of Mass*

A container with a centre of mass that can shift (e.g., loose objects in a box, liquid incompletely filling a container) or an object with most of its weight on one side (e.g., a flywheel with a shaft attached at one end) may increase the risk of a back injury occurring.

Possible Solutions:

- Packages may need to be redesigned or reoriented to bring the object's centre of mass closer to the body.
- The centre of mass can be marked on the container to help the worker predict where to grasp the load.
- A lop-sided object (e.g., typewriter) should be picked up with the centre of mass close to the body.
- The contents of a container should be packed so that the position of the contents does not shift during handling.
- When moving patients, proper communication with them (e.g., instructing them about the move, asking for their help, etc.) can reduce the risk of resistance, falls or other sudden movements that may lead to back injury to the handler.

Task Factors

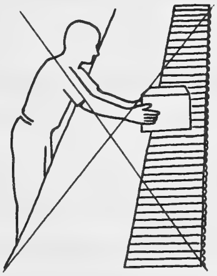
Task factors are just as important as object factors and should be considered in all job analyses for back injury risks.

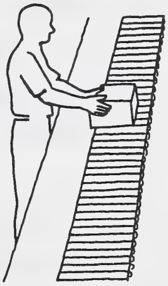
· Reach

Reach (the distance from the spine to the centre of mass of the object) is a very important back injury risk factor. The greater the reach, the greater the risk. For example, there may be up to an 80% reduction in load handling capacity with a load being held at arms' length vs being held next to the body (Health and Safety Commission--see Appendix).

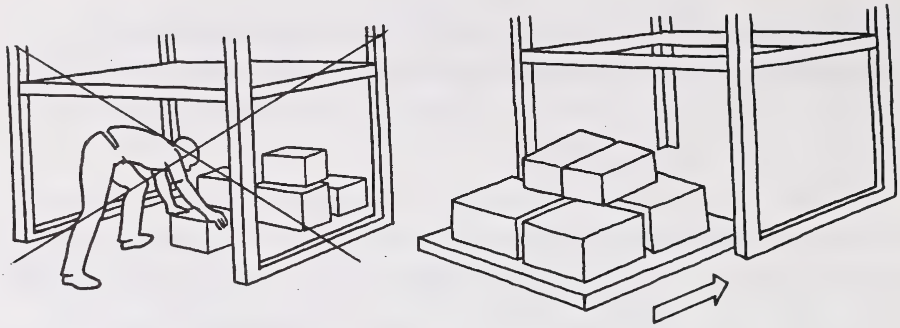
If a person is unable to reach an object by outstretching his/her arms and needs to lean forward to reach it, there is an additional load that will be placed on the back. This additional load comes from the weight of the upper body that must now be supported. For example, nurses have traditionally had to reach and bend over the bed to turn a patient. This bending may reduce a worker's safe lifting capacity by 25% with a 20 degree trunk bend. With a 90 degree bend, the safe lifting capacity may be reduced by 50% (whether the spine is kept straight or is curved) (see reference above). Reducing the need to reach, alone, can often reduce the risk to an acceptable level.

Possible Solutions:





- Redesign the object to reduce the horizontal reach distance from the body.
- Eliminate the need for workers to reach forward by making work surfaces narrower. This prevents objects from being stored or positioned far in front of the body. Otherwise, position workers on both sides of the wide surface.
- Tilt large bins or provide walk-in bins to reduce the need of reaching into them.
- To keep the work within a natural reaching arc, provide a wrap-around table or cut out a section in the front edge of an existing table.
- Provide workers with rakes or other grasping/ mechanical aids to assist the worker in pulling distant objects closer.
- Provide "lazy-Susan" surfaces (e.g., to allow the far side of a pallet to be rotated nearer to the worker).
- Move pallets away from the walls and each other. This way, workers may get at all sides of the pallet and position themselves closer to the objects that need to be handled. The same principle applies to beds in nursing homes or hospitals.



· *Frequency (Repetition) and Duration*

Repetitive lifting of a lighter weight can be just as stressful on the body as infrequent lifting of a heavier weight. Frequent lifts may lead to gradual wear and tear on the body and will certainly contribute to worker fatigue. Both of these factors can increase back injury risk. As an example, one poultry plant line had workers lifting 220 - 320 gram portions of meat more than 35 times per minute. Over a work day, this "apparently light load" works out to lifting: 462 - 672 kg/hour, 3396 - 5376 kg/8-hour day, or an average of about four tonnes/shift!

Associated with repetition is *rest*. Rest periods must be provided in any manual materials handling job to let the body (heart, muscles and other tissues) recover. Long and hard work, such as an eight-hour labouring day followed by overtime, or a 12-hour labouring day, can increase the risk of back injury due to fatigue. Increased fatigue will cause mistakes to be made, poor lifting techniques to be used (since good lifting techniques require more energy) and tired muscles (which are weaker muscles).

Manual handling jobs involve tasks other than lifting (e.g., lowering, pushing, pulling and carrying loads). The stress from all of these activities will add up to increase fatigue and, therefore, the risk of back injury.

Possible Solutions:

- Automate the most repetitive tasks. This will change the worker's job from worker-done to worker-controlled.
- For continuous, repetitive work, allow workers enough short rest periods (i.e., not just scheduled coffee breaks) to allow their tissues to recuperate. Rest breaks should be flexible and as needed by the workers, since every worker is different. It is important not to view rest periods as lost productivity but rather, as part of the job--part of the injury prevention strategy. The key principle for rest periods should be "short and often."
- Change jobs that are machine-paced to worker-paced. Not all workers

are able to do work at the same speed; nor does any one worker do work at the same speed all of the time. Allow for individual and daily variations. Optimally, allow machines to operate under the worker's control, or build in buffer zones and programmed product gaps in assembly line tasks to allow for some variation.

- Arrange for job rotation and variety. Move workers among different tasks, making sure that consecutive tasks do not involve the same types of demands on the body or mind.
- In heavy physical jobs, keep the amount of work that is done to within workers' capacities and limit the amount of overtime in these jobs. Workers can also warm up and warm down with less strenuous tasks.

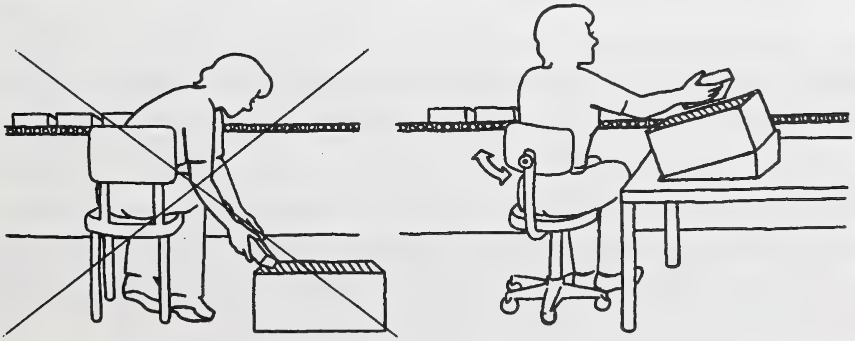
· *Twisting*

If the upper body is twisted while lifting, pushing or pulling loads, the back is put at risk of injury. Examples of jobs that involve twisting include: many traditional patient handling techniques; many manual materials handling jobs (e.g., twisting to move a load from a conveyor to a pallet); and many assembly line jobs (e.g., workers pick up or discard parts into bins that are located beside or behind them).

Twisting is especially dangerous when combined with reaching or stooping postures. It is important to evaluate and change workstations (e.g. the layout) where stressful postures exist.

Possible Solutions:

- Change the direction of materials handling (e.g., from a conveyor to a pallet) from 180 degrees (commonly seen in the workplace) to 90 degrees or less.
- Use "lazy Susan" surfaces. This allows the surface that is holding the object to rotate, rather than forcing the worker to twist.
- Make sure the tools used, or parts needed most frequently, are located in front of the worker. Items needed less frequently can be located within reach, but perhaps to the sides.



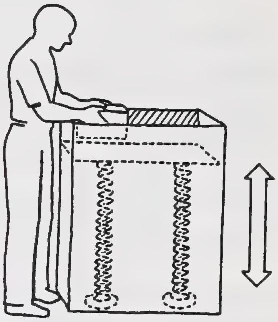
- Use pallets and forklifts to move heavy items into and out of warehouse shelving.
- If, because of the nature of the job, twisting cannot be totally eliminated, then reduce the load weight, frequency of handling, reaching components, and plan the lift even more carefully.

· *Height*

Lifts that are too low (i.e., below the knee) or too high (i.e., above the shoulder) are considered back injury risk factors. Work performed on high or low work surfaces can also contribute to increased risks.

Possible Solutions:

- Make sure that work heights are within an acceptable range for workers. Where possible, provide adjustable height work surfaces and chairs to match individual workers and work tasks.
- Provide adjustable equipment/aids such as spring-loaded bins or electric/hydraulic scissor lifts to adjust loads to the correct height for lifting.
- Items should preferably be stored between knee height (for the tallest worker) and shoulder height (for the shortest). If this is not possible, store the heaviest items in that range and lighter ones, above and below.
- Raised or adjustable-height baths, etc. are available for patient care.



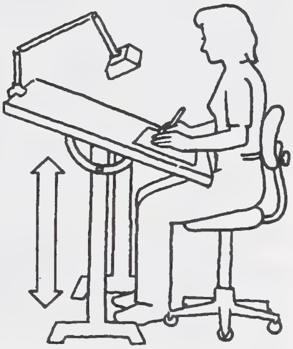
· *Dynamic vs Static Postures*

Dynamic postures involve body movement, whereas static postures, involve little or no movement. The muscles are working in both dynamic and static movements but they are doing different types of work. Lifting boxes from a conveyor to a pallet is an example of "dynamic movement." Here, muscles are working to move the body. Sitting at a computer terminal or standing at a foot-operated punch press for several hours are examples of "static movement." Here, muscles are working to hold the body in place. The risks of static postures may not be as obvious as dynamic ones, yet they too have been implicated in incidences of back pain. It is important to look at both the static and dynamic motions of work tasks for back injury risks.

Another risk situation involves conditions where workers must sit for part of their jobs and lift for another part (e.g., shippers/receivers, truckers and couriers). There is evidence that when a worker lifts immediately after a period of sitting, the susceptibility to a back injury increases.

Possible Solutions:

- All tasks should allow workers the option to change postures often enough to both use and rest different muscle groups.
- Sitting tasks should allow for occasional standing. Standing tasks should allow for occasional sitting.
- If a standing task cannot accommodate periods of sitting, then workers should be allowed to move around. Also, they may given foot supports and anti-fatigue matting to help promote some movement while performing their tasks. Another option is to provide a 'standing chair' that would allow some of the weight to be taken off the legs and back.
- A compromise workstation would be a 'sit-stand' workstation. This provides a high worksurface with a high chair (with a foot and back rest) so the worker can either sit or stand. (Note: look for a comfortable chair design.)
- Workers should be allowed and encouraged to walk or move around for a few minutes after sitting and before lifting.



Organisational Factors

· *Management Support*
Managers can be removed from the details of daily operations. Their decisions, though, influence these operations and the resources that are allocated to them. Their support and understanding of the back injury issues are necessary in any prevention effort.

· *Labour-Management Relations*
Managers or supervisors who don't respond to reported symptoms or complaints of back pain or mild injury will very likely find themselves in a situation where the minor incident evolves into a back disability case. True malin-

gering is not common. Management hesitation to provide, or union hesitation to accept, modified work and early return-to-work programs can also worsen the back injury problem.

Possible Solutions:

- Positive acceptance of back pain complaints, combined with immediate and effective treatment of the complaints (e.g., medical care, modified work, continued management caring) has been shown to dramatically reduce the length, severity and cost of back pain episodes.
- Modified work and early return-to-work following an injury can significantly reduce the physical, financial and emotional costs to both workers and employers.

· *Education*

Education of the worker in "proper lifting techniques" is normally as far as most companies go when it comes to back injury prevention education. Lifting techniques are only one component of back injury prevention education. Education is only one component of a back injury prevention strategy.

It is important to educate people at all levels in the organisation. A general awareness about the risks factors linked to back injuries and about strategies to prevent and manage back injury situations in the workplace are necessary. Information should be provided to managers, supervisors, company professionals (e.g., engineers, doctors, nurses, etc.) and others with authority to make changes or influence the way in which the organisation operates, chooses equipment, or designs the facility. For professionals such as engineers and architects (i.e., those who are involved in the design of operations, processes or equipment), education would include an in-depth focus on ergonomic principles, and how to use those principles to prevent risk situations.

It is just as important to educate workers in ways they can reduce their risk of back injury. A basic understanding of what the risk factors are is essential and can be broadened to include information about their backs (e.g., anatomy, physiology) and advice about lifting, fitness and lifestyle.

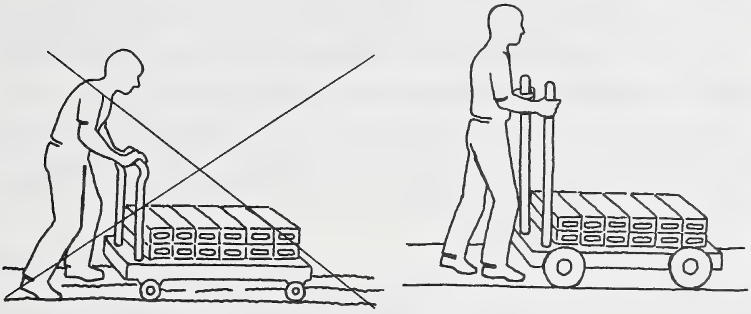
· *Equipment Purchase and Design*

Working with poorly designed equipment (even equipment meant to improve handling tasks) can lead to back injuries. Equipment, tools and workstations that do not take into consideration the person (e.g., body sizes and shapes, strengths and weaknesses, recuperative needs, and psychology needs), obviously will lead to a situation that forces the worker to try and fit the job. Ideally, the job should fit the worker.

Possible Solutions:

- Specify your ergonomic design needs to the manufacturer.
- Arrange for trial installations for workers to evaluate.

- Educate in-plant engineers and purchasing agents to look for design features that can reduce or eliminate back injury risk factors. Before purchasing or modifying equipment, ensure that the designs are compatible with workers and the job to be done.



· *Equipment and Facility Maintenance*
Lifting assists that don't work, damaged castors on wagons, rough flooring that doesn't allow wheels to turn easily, and broken equipment are all examples of cases of where poor maintenance may increase the risk of back injury.

Possible Solutions:

- Regularly scheduled maintenance (e.g., wagon, gurney and dolly castors that work properly, patched cracks in concrete floors, smoothly running conveyors, etc.) can make workers' jobs easier to do (e.g., uses less strength and twisting to do the same work) and will likely reduce the risk of back injury.
- For those workers who are doing the actual maintenance, their jobs can also be made safer. Include your maintenance needs - such as ease of access, lift points welded onto heavy parts, etc. - in your purchase specifications. Procedures should be written to ensure that heavy or awkward, lifts or reaches during maintenance are approached in a prescribed safe manner.

· *Work/Rest Periods and Overtime*
During the work day, there are both work and non-work periods such as coffee and lunch breaks, unavoidable delays, cleanup time, or recovery periods. Recovery periods are necessary when jobs can overload and stress the worker. These can be actual rest periods or changes to the work activities. Job rotation and job enrichment are strategies that can be used to change work activities.

Excessive amounts of overtime in manual handling or in static jobs can increase worker exposure to risk factors such as repetition, and add to overall fatigue.

Possible Solutions:

- Job rotation involves moving the worker periodically to other tasks that do not stress the same body parts. This can be useful when risk factors (e.g., repetition, reaching) cannot be entirely designed out.
- Job enrichment can give the worker, not only more variety in the tasks that are done, but more meaning to the job itself. For example, some automotive manufacturers have eliminated the assembly line layout and have assigned small teams to build entire cars.
- If overtime is necessary in physically demanding jobs, be sure to schedule the overtime to minimize any disruption to sleep patterns and to provide workers with adequate rest periods (i.e., short and often) during the overtime shift.

· *Incentive Pay*

Incentive pay can often encourage a worker to lift more weight per load, lift more loads per shift, work faster, or take fewer natural rest breaks. This production strategy can work against the organisation since these situations lead to the body having to work harder while discouraging time for rests (which are necessary to allow the body to recuperate). Even machines have specifications which, if surpassed, will lead to breakdown. *So do people!*

If workers are encouraged or pressured to work too much, too fast, or for too long, productivity may go up in the short term, but in the long run, worker injuries are bound to start occurring. In these situations, other less obvious costs will start to emerge, such as those associated with absenteeism, worker turnover/hiring and training, production down-time, etc.

Possible Solutions:

- Carefully examine your production strategy. Ensure your incentives are not contributing to overload situations that will ultimately work against you.
- If incentive pay must remain, program-in short, frequent rests (e.g., cut off power supply, shut down machines) to build in the necessary rest periods needed to allow tissues to recuperate.

Environmental Factors

· *Obstacles*

Sometimes work areas are arranged so a worker needs to reach over something to grasp or move a load. This means, as the worker reaches over the barrier to lift the object, the horizontal distance of the lift increases. If the barrier were not there, the worker could slide the object closer to the body and then lift it. This would decrease the horizontal distance of the lift.
Whenever there is inadequate space underneath a work area (e.g., desks or benches), the worker will be unable to comfortably position their knees or feet underneath the work surface. The result of this is that the worker must now

reach or bend forward to do the work.

Possible Solutions:

- Redesign storage shelves, bins, etc. to remove unnecessary barriers that require workers to reach over before handling loads.
- Regular housekeeping can ensure that objects are not unnecessarily stored underneath work surfaces or left on the floor.
- Make sure that standing workstations are provided with adequate space for the feet.
- Make sure that sitting workstations are provided with adequate space for the knees and feet.

· *Footing/Flooring*

In a materials handling environment, slippery surfaces, uneven flooring (e.g., cracks in the floor), sloping floors (e.g., ramps), or stairs can increase the likelihood of a back injury occurring. These conditions may require the worker to use more effort or more stressful postures to balance, control and move things. When lighting is poor, the worker may not see a hazard, so the chance of slipping, tripping, losing balance, etc. can increase.

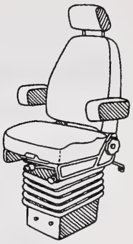
Possible Solutions:

- Keep manual handling on one level (i.e., eliminate the need to climb ramps or stairs, where possible).
- Keep floors in good condition. Maintain regularly and repair when needed.
- Shoes that are worn by workers should have a sole material and design that is compatible with the flooring or the materials (e.g., liquids, dusts) that can collect on the floor between clean-up periods.

· *Vibration*

Workers can be exposed to whole body vibration when they operate vehicles such as trucks, forklifts, forestry equipment and earth-moving equipment. Exposure to whole body vibration can increase the risk of back injury, especially if combined with prolonged sitting and followed by manual handling activities. Constant walking on hard (e.g., cement) floors also can stress the lower back (and some other joints) and may contribute to back pain and injury.

Possible Solutions:

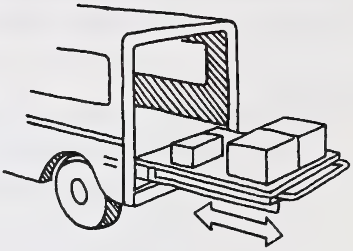


- Whole body vibration in vehicles may be reduced through improved vehicle suspension, vibration-damping seating, improved location of the operator and, in some cases, by improved road or floor surfaces. Analysing situations for exposure to vibration is a complex subject. It may involve considerable time and will require someone who is trained to properly evaluate and improve the situation.
- If prolonged standing or walking cannot be designed out, anti-fatigue matting or viscoelastic shoe insoles may help workers to cope with the hard flooring.

· *Space*

Confined spaces usually lead to awkward postures. For example, couriers may need to stoop to lift heavy boxes that are located in the back of the van.

Possible Solutions:



- There are pull-out beds available for vans and pick-up trucks. This will enable the worker to position him/herself closer to the object that is being lifted, rather than stooping and reaching over.
- An industrial manipulator can be used to reach and lift the objects that are stored on deep shelves.
- Deep shelving can be changed to narrow shelving so that the maximum distance that a worker would have to reach is reduced.

CONTROVERSIAL AREAS

Abdominal Belts

Abdominal belts (also called lifting belts or back belts) are being promoted as a way to help prevent back injuries to workers. The scientific evidence, so far, does not support these claims. Some belts do increase pressure within the abdomen, but this does not appear to reduce the compressive loads on the spine. Some belts may serve as a kind of splint to restrict the range of motion of the back. This may help to preserve the natural "hollow," or curvature, in the low back with sideways bending, but they do not maintain the hollow during forward bending (a common lifting posture).

Caution needs to be applied when healthy workers wear these belts. They may develop a false sense of security and attempt to lift more. In addition, injured workers may continue to work, thinking these belts will support them. This may make an existing back problem worse. There is some evidence that injuries may increase when workers stop using belts, and that it would be unwise for a person who is at cardiovascular risk to wear a belt for lifting since belt wearing increases blood pressure.

Even if it turns out that these belts are of some value in heavy lifting situations, the fact that a company feels they are necessary is a clear indication that the company's manual handling tasks are stressful on workers. The most effective approach to back injury prevention is to ensure the demands on the lower back are removed through proper task design.

CONCLUSIONS

This booklet has looked at some of the risk factors that can contribute to back pain and disability, and also at possible ways of reducing those risks. Some approaches are more effective than others. The success of your back injury prevention efforts will depend upon what approach or approaches are used. The issue of back pain and disability is a very complex one and no single approach will solve all of the problems on its own. Ergonomics is considered to be the most effective strategy that a company can use to prevent back injuries.

The booklet has highlighted some ergonomics principles and solutions that could be applied to back injury prevention. A broader approach -- implementing design changes, educating more than just workers (i.e., decision-makers in the company), changing the attitudes and responses to back pain complaints, improving medical management of injuries -- increases the likelihood of reducing the pain, suffering and costs arising from occupational back injuries.

APPENDIX -- RESOURCES

Organizations

ALBERTA LABOUR

Ergonomics Program
4th fl., 10709 Jasper Avenue
EDMONTON, Alberta
T5J 3N3
Telephone: **427-2687**

Occupational Health and Safety Officer (Ergonomist)
2nd fl., 1021 - 10 Avenue SW
CALGARY, Alberta
T2R 0B7
Telephone: **297-7874**

OHS Library
6th fl., 10709 Jasper Avenue
EDMONTON, Alberta
T5J 3N3
Telephone: **427-3530**

HUMAN FACTORS ASSOCIATION OF CANADA
6519B Mississauga Road
MISSISSAUGA, Ontario
L5N 1A5
Telephone: **416/567-7193**

NATIONAL RESEARCH COUNCIL
Industrial Development Office
OTTAWA, Ontario
K1A 0R6
Telephone: **613/993-5509**

CANADIAN CENTRE FOR OCCUPATIONAL HEALTH AND SAFETY
250 Main Street East
HAMILTON, Ontario
L8N 1H6
Telephone: **416/572-2981**
1-800-263-8276

Books and Other Reading Materials

Swedish Work Environment Fund. (1988). Making the job easier: An ergonomics idea book. (L.E. Scott, Trans.). National Safety Council.

Troup, J.D.G., Lloyd, P., Osborne, C., and Tarling, C. (1981). The handling of patients: A guide for nurse managers. Middlesex: Back Pain Assn., and London: Royal College of Nursing.

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